Not to be cited without
permission of the authors[1]

Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC Research Document 88/57

Ne pas citer sans
autorisation des auteurs[1]

Comité scientifique consultatif des
pêches canadiennes dans l'Atlantique

CSCPCA Document de recherche 88/57

An Update on the Status of 4VWX Flatfish Stocks

by

John D. Neilson and Peter Perley

Marine Fish Division
Department of Fisheries and Oceans
Biological Station
St. Andrews, New Brunswick E0G 2X0
Canada

[1]This series documents the scientific basis for fisheries management advice in Atlantic Canada. As such, it addresses the issues of the day in the time frames required and the Research Documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research Documents are produced in the official language in which they are provided to the Secretariat by the author.

[1]Cette série documente les bases scientifiques dess conseils de gestion des pêches sur la côte atlantique du Canada. Comme telle, elle couvre les problèmes actuels selon les échéanciers voulus et les Documents de recherche qu'elle contient ne doivent pas être considérés comme des énoncés finals sur les sujets traités mais plutôt comme des rapports d'étape sur les études en cours.

Les Documents de recherche sont publiés dans la langue officielle utilisée par les auteurs dans le manuscrit envoyé au secrétariat.

ABSTRACT

Landings of 4V American plaice, 4VW witch flounder and 4VWX yellowtail flounder (stocks comprising the 4VWX flatfish complex under TAC management) have increased from 7,392 t in 1986 to 9,134 t in 1987, a 24% increase. While landings remain at low levels compared with those obtained in late 1960's and early 1970's, it is doubtful whether this reflects reduced stock abundance. Time series of total directed effort for 4V American plaice and 4VW witch flounder support the view that the directed effort for those stocks has decreased over time. However, the declining research vessel indices of abundance for 4V American plaice and 4VW witch flounder give contradictory indications to some extent. Although speculative, it may be that recent changes in the availability of American plaice to the survey gear may be responsible for the decline in the index. Given the increasing uncertainties regarding the use of commercial and research vessel CPUE, we can no longer advise on TAC for the stock complex. We recommend that to better reflect the current appreciation of stock structure, separate biological updates or assessments be conducted for 4VW American plaice, and yellowtail and witch flounder in 4VWX.

RÉSUMÉ

Les débarquements de plie canadienne de 4V, de plie grise de 4VW et de limande à queue jaune de 4VWX (stocks comprenant le complexe de poissons plats de 4VWX conformément à la gestion par TPA) sont passés de 7 392 t en 1986 à 9 134 t en 1987, soit une augmentation de 24 %. Même si le niveau des débarquements est demeuré faible par rapport à ceux enregistrés à la fin des années 1960 et au début des années 1970, on ne sait pas si cette situation traduit une réduction de l'abondance des stocks. Les séries chronologiques portant sur l'effort total monospécifique sur la plie canadienne de 4V et la plie grise de 4VW appuie l'opinion selon laquelle l'effort monspécifique portant sur ces stocks a diminué au cours des années. Toutefois, la baisse des indices d'abondance provenant des navires de recherche au sujet de la plie canadienne de 4V et de la plie grise de 4VW ont donné des résultats contradictoires jusqu'à un certain point. Bien qu'ayant une valeur spéculative, il est possible que les modifications récentes de la vulnérabilité de la plie canadienne aux engins de reconnaissance soient responsables de la baisse de l'indice. Compte tenu des incertitudes de plus en plus grandes relativement à l'utilisation du CPUE des navires commerciaux et des navires de recherche, nous ne pouvons plus donner d'avis sur le TPA pour les stocks du complexe. Afin de mieux refléter l'évaluation ordinaire de la structure du stock, nous recommandons d'effectuer des mises à jour ou des évaluations biologiques distinctes pour la plie canadienne de 4V, et la limande à queue jaune et la plie grise de 4VWX.

105-04681/

INTRODUCTION

Four members of the Pleuronectidae (exclusive of the halibuts) are exploited commercially on the Scotian Shelf. Listed in order of decreasing landings in 1987, they are:

American plaice (Hippoglossoides platessoides)
Witch flounder (Glyptocephalus cynoglossus)
Yellowtail flounder (Limanda ferruginea)
Winter flounder (Pseudopleuronectes americanus)

Of these, only American plaice, witch flounder and yellowtail founder are under quota management. The three species are treated together for the purposes of establishing a TAC. The landings of winter flounder typically are comparatively low, although locally significant along the Nova Scotia coast and in the Bay of Fundy (Halliday 1973).

DESCRIPTION OF THE FISHERY

Landings of Scotian Shelf flatfish (American plaice, witch flounder and yellowtail founder) were 9,134 t in 1987 compared with 7,392 t in 1986, a 24% increase (Table 1, Fig. 1). In addition, 1987 marks the first year since 1984 that flatfish landings have increased compared with the previous year. Among the species complex comprising Scotian Shelf flatfish, American plaice landings have increased from 3,649 t last year to 4,849 t this year. Landings in Division 4V account almost exclusively for the increase in Shelf-wide landings (Table 2). Witch landings have increased marginally from 2,939 t in 1986 to 3,136 t in 1987 (Table 3). Yellowtail flounder landings have increased from 804 t in 1986 to 1149 t in 1987 (Table 4). Winter flounder catches have decreased slightly from 1037 t to 1029 t over the same period (Table 5). The nominal catches of the various flatfish are also presented in Tables 6-9, where they are aggregated by gear type. The most significant gear type for American plaice, yellowtail and winter flounder fisheries is the stern otter trawler, and for the witch flounder fishery, Danish and Scottish seines.

Details of landings by gear component and month are given in Neilson and Perley (1986).

INDICES OF ABUNDANCE

Commercial CPUE

The directed catches of all stocks comprising the 4VWX complex were at a very low level in 1987, making the interpretation of CPUE statistics difficult, and the use of multiplicative analyses, as done in 1986 (Neilson and Perley 1986) impossible. This is indicated by Fig. 2, which shows the directed effort towards American plaice and witch from 1968 to 1988. Effort has declined on the average, particularly with the removal of effort associated with the side trawler fleet in 1984.

An exception to the above is the Danish/Scottish seine fishery for 4VW witch flounder, where there appears to be a useful CPUE series available (Fig. 3). The CPUE series showed a steady decline from 1968 to 1977, and then a recovery from 1978 to 1986, with a recent drop in 1987. The series

tracks landings reasonably well. However, even in this instance, directed effort has dropped considerably, with 7418 h fished in 1977, compared with 964 h fished in 1987.

Research Vessel Surveys

The stratified catch per tow for 4V American plaice has declined markedly in 1987 compared with 1986, as have comparable values for 4VW witch flounder. However, the yellowtail flounder abundance index has increased compared with 1986 value (Table 10). Figure 4 shows the relationship between stratified numbers caught per tow vs landings for American plaice, witch and yellowtail flounder. Some coincidence in the trends is apparent, but there are often considerable discrepancies. Moreover, the standardized CPUE series from the commercial fishery presented in Neilson and Perley (1986) does not compare well with the stratified numbers caught per tow for 4V plaice (Fig. 5), particularly in more recent years, when the total directed effort in the plaice fishery has decreased considerably.

The stratified catch for American plaice is shown for both males and females in Table 11. Comparatively large year-classes are apparent in 1972 and 1977, and the strong cohorts remain evident until ages 7 or 8 in both the male and female data. They are also apparent in the length- frequency plots from the research vessel surveys (Fig. 6 & 7 for males and females, respectively). Apart from the appearance of those strong year-classes, there is no indication of significant differences in size or age composition over the period 1970-1986. However, no such strong year-classes are apparent in the more recent data.

OTHER CONSIDERATIONS

Discussions of past assessments have raised the following questions:

1. Consider examining trends in total catch and effort for selected areas, as possible indicators of abundance.

As indicated above, the decline in commercial fishery directed effort is such that insufficient data are available for analyses on that basis. However, we investigated the RV data further, using a stepwise regression of stratified mean numbers and weights caught in individual strata on landings for 4V American plaice. We used strata 47, 48, 49 and 50 in the regression model, on the basis that consistently large catches were taken in those strata from year to year. Only one stratum (50) was selected for inclusion in the model, for both stratified numbers and biomass/tow. The explanatory power was low, with 40 and 29% of observed variability in landings accounted for by numbers and weights respectively in stratum 50 (Table 12a and b, Fig. 8). While we conclude that there is only marginal utility to using such statistics in a limited area as an index of overall stock abundance, it represents a considerable improvement over the correlation of the overall stratified mean catch per tow for 4V and landings, where the slope of the regression in non-significant ($p=0.897$). Of course, the landings data are probably not the best dependent term to use in the model as there is no adjustment for the effects of effort, but as noted earlier, the CPUE data are no longer reliable.

2. Examine the basis for the TAC, and evaluate the appropriateness of the criteria used to set it.

The history of the TAC for the stock complex and the corresponding nominal landings are shown in Fig. 9. Over the history of its management, landings have never exceeded the TAC.

An initial TAC of 32,000 t was established apparently in response to yield per recruit calculations made by Halliday (1973). That initial TAC was reduced to 28,000 t because of observed over-exploitation of plaice in Div. 4W and substantial declines in yellowtail stocks (Halliday 1976).

The reduction in TAC in 1978 to 14,300 t seems to be in response to a suggestion made in an Advisory Document (Anon. 1977) that an appropriate TAC would be 14,000 t, with the removal of Soviet and Spanish fishing effort. An excerpt from the Advisory Document explains the rationale for the considerable reduction in TAC: "...if in fact the USSR did catch large quantities of flatfish in 4W, it would be mainly as a bycatch. At this moment, there are no guarantees that Canada could replace the USSR effort in Div. 4W with an economically viable directed fishery. Secondly, there are known to have been substantial faltfish bycatches in the Spanish cod fishery in Div. 4VW which have not been reported in the statistics. Lastly, the biological basis for stock assessment is weak and warrants a conservative approach to stock management. This combined with elimination of the USSR and Spain from the fishery, is a reasonable first step to placing the fishery on an economic basis."

Subsequent examination of the stock complex by Cleary (1979) using catch and effort analyses led her to suggest that with the removal of foreign fishing effort, flatfish stocks were recovering. Metuzals (1980, 1981) used similar analyses, along with examination of research vessel CPUE to suggest that total biomass was relatively stable and would continue to support the present fishing pressure. The next review of the stock was by Dale and O'Boyle (1983), who indicated that despite fluctuations in individual species abundance, the biomass of the stock complex is stable and will continue to support current levels of exploitation. A similar conclusion was reached by Neilson and Dale (1984). Neilson and Perley (1985) used a status quo technique for assessing the appropriateness of the TAC and concluded that the existing TAC was likely too high. However, they were not able to suggest a revised TAC with any degree of certainty. A substantial drop in total landings in 1985 was attributed to decreased directed effort, not decreased abundance. Hence, no modification to the TAC was indicated (Neilson and Perley 1986), and the 14,000 t TAC remains in effect at present.

3. Examine increasing trends for catches to be identified as unspecified flounder.

The proportion of landings indentified as such has increased dramatically since 1970, as shown in Fig. 10. The area where most of the

problem seems to be occurring is NAFO Division 4X, as shown below where the nominal landings of nonspecified flounder are broken down by Division:

Year	4V	4W	4X
1972	42	0	723
1973	64	3	873
1974	199	2	817
1975	5	283	1122
1976	61	486	1043
1977	27	19	944
1978	5	28	1060
1979	40	51	1303
1980	23	6	1887
1981	17	4	1577
1982	4	7	1774
1983	30	20	2071
1984	6	2	2002
1985	3	7	2210
1986	46	22	3219

This problem was discussed with staff of Economics Branch, Scotia-Fundy Region. A memo has been prepared and forwarded to the Statistics Branch for distribution to the field staff. However, a potential difficulty is that if plant operators were somehow coerced to classify their flatfish catches more precisely, they might arbitrarily and incorrectly assign species identification. It might be better to accept the unspecified flounder data, and attempt to pro-rate on known species proportions observed from either groundfish surveys or from a specific sampling study at plants identified to be contributing to the problem. The latter approach will be investigated jointly with the Economics Branch.

PROGNOSIS

While landings of flatfish species under TAC management continued at a low level compared with those obtained in the pre-1977 period, we view this as being not necessarily indicative of reduced stock abundance. It seems more likely that decreased landings reflect decreased effort towards those species, a view supported by Fig. 2. However, the declining research vessel indices of abundance for 4V American plaice and 4VW witch flounder counter this argument to some extent. Although speculative, it may be that recent changes in the availability of American plaice to the survey gear may be responsible for the decline in the index. Such a decline has been noted last year in another American plaice stock which is not exploited (R. Bowering, pers. comm.).

Given the increasing uncertainties regarding the use of commercial and research vessel CPUE, we can no longer advise on TAC for the stock complex. We recommend that to better reflect the current appreciation of stock structure (Neilson et al. 1988), separate biological updates or assessments be conducted for 4VW American plaice, and yellowtail and witch flounder in 4VWX.

LITERATURE CITED

Anon. 1977. CAFSAC Advisory Doc. 77/4, 3 p.

Cleary, L. 1979. Flatfish of the Scotian shelf, CAFSAC Res. Doc. 79/27, 48 p.

Dale, C. E., and R. O'Boyle. 1983. A biological review of the status of the 4VWX flatfish stocks. CAFSAC Res. Doc. 83/62, 22 p.

Halliday, R. G. 1973. The flatfish fisheries of the Scotian Shelf. ICNAF Res. Doc. 73/102, 46 p.

Halliday, R. G. 1976. Scotian Shelf flatfish stocks - implications of 1975 data. ICNAF Res. Doc. 76/VI/24, 5 p.

Metuzals, K. I. 1980. Flatfish 4VWX update of the status in 1979 of: American plaice, yellowtail flounder, witch flounder, winter flounder, Atlantic halibut and Greenland halibut. ICNAF Res. Doc. 80/36, 21 p.

Metuzals, K. I. 1981. Flatfish stock trends of the Scotian Shelf. CAFSAC Res. Doc. 81/62, 42 p.

Neilson, J. D., and C. E. Dale. 1984. A review of the status of the 4VWX flatfish stocks. CAFSAC Res. Doc. 84/54, 35 p.

Neilson, J. D., and P. Perley. 1985. A review of the status of the 4VWX flatfish stocks (exclusive of the halibuts). CAFSAC Res. Doc. 85/42, 32 p.

Neilson, J. D., and P. Perley. 1986. A review of the status of the 4VWX flatfish stocks (exclusive of the halibuts). CAFSAC Res. Doc. 86/69, 30 p.

Neilson, J. D., E. DeBlois, and P. C. F. Hurley. 1988. Stock structure of Scotian Shelf flatfish as inferred from icthyoplankton survey data and the geographic distribution of mature females. Can. J. Fish. Aquat. Sci. 45: 1674-1685.

Table 1. Total landings (t) for 4VWX flatfish between 1963-87.

Year	American plaice	Witch flounder	Yellowtail flounder	Winter flounder	Flatfish (N.S.)	Total
1963	2309	7486	3972	696	-	14,463
1964	3082	8629	5399	1311	194	18,615
1965	8198	12943	6104	1339	90	28,674
1966	14206	14512	4851	1346	30	34,945
1967	10770	7816	5196	944	-	24,726
1968	19265	21682	13128	1181	-	55,256
1969	13735	14093	3826	1416	-	33,070
1970	8358	6048	3682	1530	11	19,629
1971	14301	17864	1775	3084	1	37,025
1972	10653	11351	1485	1454	723	25,666
1973	12432	13969	1513	1909	873	30,696
1974	16772	7415	939	2756	817	28,699
1975	11747	8922	1568	1374	1122	24,733
1976	11147	5742	904	1297	1043	20,133
1977	7752	2431	1443	1257	944	13,827
1978	6756	2291	1628	1207	1060	12,942
1979	6354	2071	2090	1088	1303	12,906
1980	7572	2321	2491	1174	1887	15,445
1981	6772	1741	2889	1448	1577	14,427
1982	5697	1473	2623	1236	1774	12,803
1983	6105	1659	2423	993	2071	13,251
1984	6127	1932	2462	881	2001	13,403
1985[1]	4437	2269	1020	823	2210	10,759
1986[1]	3649	2939	804	1037	3287	11,716
1987[2]	4849	3136	1149	1030	-	10,164

[1]All countries except USA
[2]Provisional (Canadian catches only)

Table 2. American plaice landings (t) for NAFO Division 4VWX for 1963-87.

Year	4V	4W	4X	Total	Canadian catch		Foreign catch	
1963	1376	683	250	2309	2108	(91)[2]	201	(9)
1964	1967	603	512	3082	2838	(92)	244	(8)
1965	4707	2797	694	8198	5542	(68)	2656	(32)
1966	8167	5313	726	14206	9113	(64)	5093	(36)
1967	8884	780	1106	10770	10524	(98)	246	(2)
1968	10489	7830	946	19265	9828	(51)	9437	(49)
1969	8076	4789	870	13735	9300	(68)	4435	(32)
1970	5242	2481	635	8358	6303	(75)	2055	(25)
1971	7765	5991	545	14301	7513	(53)	6788	(47)
1972	6912	3175	566	10653	6855	(64)	3798	(36)
1973	8686	3407	339	12432	5146	(41)	7286	(59)
1974	11363	4951	458	16772	6967	(42)	9805	(58)
1975	7336	4115	296	11747	6623	(56)	5124	(44)
1976	8488	2350	309	11147	6932	(62)	4215	(38)
1977	6711	592	449	7752	7654	(99)	98	(1)
1978	5501	743	512	6756	6679	(99)	77	(1)
1979	5028	498	828	6354	6329	(100)	25	(0)
1980	6293	598	681	7572	7490	(99)	82	(1)
1981	5677	581	514	6772	6586	(97)	186	(3)
1982	4920	400	377	5697	5621	(99)	76	(1)
1983	5095	428	582	6105	5964	(98)	141	(2)
1984	5509	284	334	6127	5939	(97)	188	(3)
1985	3915	205	317	4437	4365	(98)	72	(2)
1986[1]	2792	297	560	3649	3620	(99)	29	(1)
1987[3]	4222	376	251	4849	4849	(100)	-	

[1]All countries except USA.
[2]Percentage of total catch.
[3]Canadian catches only.

Table 3. Witch flounder landings (t) for NAFO Division 4VWX for 1963-87.

Year	4V	4W	4X	Total	Canadian catch		Foreign catch	
1963	4971	2440	75	7486	6972	(93)[2]	514	(7)
1964	5808	2564	257	8629	8406	(97)	223	(3)
1965	5068	7454	421	12943	7710	(60)	5233	(40)
1966	5241	9047	224	14512	7046	(49)	7466	(51)
1967	5740	1693	383	7816	7496	(96)	320	(4)
1968	7598	13349	735	21682	8772	(40)	12910	(60)
1969	4338	8963	792	14093	6671	(47)	7422	(53)
1970	3282	1959	807	6048	4920	(81)	1128	(19)
1971	5640	11083	1141	17864	6816	(38)	11048	(62)
1972	4894	5759	698	11351	5909	(52)	5442	(48)
1973	6572	6862	535	13969	5854	(42)	8115	(58)
1974	4913	2004	498	7415	5830	(79)	1585	(21)
1975	3284	5307	331	8922	3406	(38)	5516	(62)
1976	2718	2683	341	5742	2466	(43)	3276	(57)
1977	1555	455	421	2431	2307	(95)	124	(5)
1978	1540	563	188	2291	2139	(93)	152	(7)
1979	1572	209	290	2071	2057	(99)	14	(1)
1980	1801	189	331	2321	2298	(99)	23	(1)
1981	1123	156	462	1741	1687	(97)	54	(3)
1982	789	101	583	1473	1411	(96)	62	(4)
1983	878	126	655	1659	1474	(87)	185	(13)
1984	1191	149	592	1932	1737	(89)	195	(11)
1985[1]	1633	113	523	2269	2133	(94)	136	(6)
1986[3]	2224	162	553	2939	2885	(98)	54	(2)
1987[3]	2541	125	470	3136	3136	(100)	-	

[1]All countries except USA.
[2]Percentage of total catch.
[3]Canadian catches only.

Table 4. Yellowtail flounder catch (t) for NAFO Division 4VWX for 1963-87.

Year	4V	4W	4X	Total	Canadian catch		Foreign catch	
1963	1740	2148	84	3972	3784	(95)[2]	188	(5)
1964	4084	1165	150	5399	5288	(98)	111	(2)
1965	4330	1550	224	6104	5378	(88)	726	(12)
1966	3521	1164	166	4851	3770	(78)	1081	(22)
1967	3808	1163	225	5196	5152	(99)	44	(1)
1968	6953	5970	205	13128	5377	(41)	7751	(59)
1969	2491	1134	201	3826	1263	(33)	2563	(67)
1970	670	2686	326	3682	947	(26)	2735	(74)
1971	889	668	218	1775	1033	(58)	742	(42)
1972	697	624	164	1485	1007	(68)	478	(32)
1973	980	394	139	1513	424	(28)	1089	(72)
1974	573	130	236	939	593	(63)	346	(37)
1975	1101	254	213	1568	1083	(69)	485	(31)
1976	473	201	230	904	610	(67)	294	(33)
1977	1101	40	302	1443	1424	(99)	19	(1)
1978	1085	156	387	1628	1610	(99)	18	(1)
1979	1655	144	291	2090	2088	(100)	2	(0)
1980	2158	78	255	2491	2486	(100)	5	(0)
1981	2539	123	227	2889	2881	(100)	8	(0)
1982	2360	51	212	2623	2620	(100)	3	(0)
1983	2043	59	321	2423	2422	(100)	1	(0)
1984	2239	51	171	2461	2449	(100)	12	(0)
1985[1]	932	15	73	1020	1014	(99)	6	(1)
1986[3]	671	22	111	804	804	(100)	-	
1987[3]	947	94	108	1149	1149	(100)	-	

[1]All countries except USA.

[2]Percentage of total catch.

[3]Canadian catches only.

Table 5. Winter flounder catch (t) for NAFO Division 4VWX for 1963-87.

Year	4V	4W	4X	Total	Canadian catch		Foreign catch	
1963	17	65	614	696	668	(96)[2]	28	(4)
1964	12	19	1280	1311	1282	(98)	29	(2)
1965	32	179	1128	1339	1237	(92)	102	(8)
1966	55	34	1257	1346	997	(74)	349	(26)
1967	37	5	902	944	926	(98)	18	(2)
1968	10	28	1143	1181	1128	(96)	53	(4)
1969	4	12	1400	1416	1392	(98)	24	(2)
1970	8	44	1478	1530	1480	(97)	50	(3)
1971	237	1364	1483	3084	1430	(46)	1654	(54)
1972	78	551	825	1454	824	(57)	630	(43)
1973	480	655	774	1909	904	(47)	1005	(53)
1974	777	1005	974	2756	1321	(48)	1435	(52)
1975	179	525	670	1374	802	(58)	572	(42)
1976	235	345	717	1297	908	(70)	389	(30)
1977	226	9	1022	1257	1244	(99)	13	(1)
1978	186	137	884	1207	1202	(100)	5	(0)
1979	228	13	847	1088	1085	(100)	3	(0)
1980	30	10	1134	1174	1173	(100)	1	(0)
1981	26	11	1411	1448	1448	(100)	-	
1982	82	10	1144	1236	1231	(100)	5	(0)
1983	72	8	913	995	992	(100)	3	(0)
1984	2	5	874	881	877	(100)	4	(0)
1985[1]	27	2	795	824	823	(100)		(0)
1986[1]	2	4	1031	1037	1037	(100)	-	(0)
1987[3]	8	3	1018	1029	1029	(100)	-	(0)

[1]All countries except USA.
[2]Percentage of total catch.
[3]Canadian catches only.

Table 6. Nominal catch (t) of American plaice by gear in NAFO Division 4V for all countries, 1972-87 (# of Canadian commercial fishery samples indicated in parentheses).

Year	Side otter trawl	Stern otter trawl[3]	Danish and Scottish seine	Longline	Other[1]	Total
1972	3012 (4)	3267	364	189	80	6912 (4)
1973	1971 (2)	5987 (2)	482	152	94	8686 (4)
1974	2193 (7)	8318	510	125	217	11363 (7)
1975	2779 (5)	3455 (1)	657	171	274	7336 (6)
1976	2438 (4)	4678 (3)	1178 (8)	87	107	8488 (15)
1977	2661 (5)	2285 (4)	1443 (17)	218	104	6711 (26)
1978	1766 (9)	2150 (6)	1222 (11)	164	199	5501 (26)
1979	1745 (11)	2201 (4)	806 (1)	192	84	5028 (16)
1980	1871 (12)	2674 (9)	1523 (3)	211	14	6293 (24)
1981	2080 (14)	2222 (7)	941 (1)	431 (4)	3	5677 (26)
1982	1868 (12)	1546 (8)	716 (3)	786 (1)	4	4920 (24)
1983	1159 (1)	2192(14)	1020 (7)	702 (2)	22	5095 (24)
1984	1336 (4)	2326(11)	1270 (1)	559 (3)	18	5509 (19)
1985[2]	42 (2)	2513	732 (4)	614 (2)	14	3915 (8)
1986[2]	34 (3)	1339 (3)	670 (3)	679	70	2792 (9)
1987[4]	65	2587(14)	702 (4)	808 (1)	60	4221 (19)

[1]Includes NK and MISC gears.
[2]All countries except USA.
[3]On the basis of purchase slip information and log records, catches recorded as unspecified otter trawl were assumed to be from stern otter trawlers. This assumption also holds for data in Tables 7-9.
[4]Canadian catches only.

Table 7. Nominal catch (t) of witch flounder by gear in NAFO Division 4VW for all countries, 1972-87 (# of Canadian commercial fishery samples taken indicated in parentheses).

Year	Side otter trawl	Stern otter trawl	Danish & Scottish seine	Other[1]	Total
1972	2459 (2)	6925	1257 (2)	12	10,653 (4)
1973	2194 (2)	9700 (1)	1464 (1)	76	13,434 (4)
1974	1968 (4)	3675 (2)	1221 (2)	53	6,917 (8)
1975	1121 (5)	6360 (4)	995 (1)	115	8,591 (10)
1976	751	3709 (2)	869 (12)	72	5,401 (14)
1977	272 (2)	785 (6)	838 (8)	115	2,010 (16)
1978	406 (11)	715 (3)	930 (12)	52	2,103 (26)
1979	419 (1)	512 (1)	792 (7)	58	1,781 (9)
1980	290 (7)	791 (5)	866 (5)	43	1,990 (17)
1981	342 6)	354 (3)	564 (1)	19	1,279 (10)
1982	164 (1)	209 (1)	511 (2)	6	890 (4)
1983	95	218 (6)	678 (6)	13	1004 (12)
1984	55 (3)	245 (5)	1017 (2)	23	1340 (10)
1985[2]	11 (1)	501 (2)	1200 (7)	34	1746 (10)
1986[3]	13	772 (2)	1551 (9)	49	2385 (11)
1987[3]	17	821 (1)	1764 (6)	65	2667 (7)

[1]Includes NK and MISC gears.
[2]All countries except USA.
[3]Canadian catches only.

Table 8. Nominal catch (t) of yellowtail flounder by gear in NAFO Division 4VWX for all countries, 1972-87 (# of Canadian commercial fishery samples taken indicated in parentheses).

Year	Side otter trawl	Stern otter trawl	Danish and Scottish seine	Longline	Other[1]	Total
1972	787 (1)	622	63	11	2	1485 (1)
1973	327 (1)	1094	71	20	1	1513 (1)
1974	208 (1)	640	56	32	3	939 (1)
1975	647	832 (1)	40	49	-	1568 (1)
1976	209	610	61	24	-	904
1977	769 (3)	444 (3)	141	14	75	1443 (6)
1978	684 (6)	729 (1)	92 (3)	18	105	1628 (10)
1979	1239	653	132	42	24	2090
1980	1306 (10)	837 (6)	299	11	38	2491 (16)
1981	1622 (19)	1032 (10)	174	13	48	2889 (29)
1982	1853 (18)	694 (7)	62	14	-	2623 (25)
1983	1390 (9)	746 (19)	187	32	68	2423 (28)
1984	1305 (6)	791 (12)	313	38	14	2461 (18)
1985[2]	9 (1)	677	246	82	6	1020 (1)
1986[3]	6	490 (5)	133	148	28	805 (5)
1987[3]	5	556 (5)	148	230	211	1150 (5)

[1]Includes NK and MISC gears.
[2]All countries except USA.
[3]Canadian catches only.

Table 9. Nominal catch (t) of winter flounder by gear in NAFO Division 4VWX for all countries, 1972-87 (# of Canadian commercial fishery samples taken in parentheses).

Year	Side otter trawl	Stern otter trawl	Longline	Danish and Scottish seine	Other[1]	Total
1972	249	1135	39	1	30	1454
1973	527 (2)	1290	39	2	51	1909 (2)
1974	784	1818	2	98	54	2756
1975	456	810	14	32	62	1374
1976	546 (10)	661 (1)	41	15	34	1297 (11)
1977	566	480 (3)	40	2	169	1257 (3)
1978	512	575	50	8	62	1207
1979	290	635 (1)	70	18	75	1088 (1)
1980	2 (1)	962	52	21	137	1174 (1)
1981	18	1303 (9)	57	8	62	1448 (9)
1982	72	1064 (13)	35	7	58	1236 (13)
1983	-	882 (13)	11	7	93	993 (13)
1984	3	728 (13)	6	3	141	881 (13)
1985[2]	11	711 (6)	6	11	85	824 (6)
1986[3]	18	918 (7)	0	2	98	1036 (7)
1987[3]	-	881 (3)	32	9	108	1030 (3)

[1]Includes NK and MISC gears.

[2]All countries except USA.

[3]Canadian catches only.

Table 10a. American plaice research[1] CPUE in NAFO Division 4V for 1970-87.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Research #/tow	79.83	79.11	70.79	40.75	98.66	60.69	82.56	57.21	26.16	88.46	115.84	90.70	75.91	83.16	97.43	69.93	48.07	39.62

Table 10b. Witch flounder commercial and research[1] CPUE in NAFO Division 4VW for 1970-87.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Canadian OTB1/TC4 (t/h)	.137	.161	.182	.251	.243	.126	.059	.016	.076	.065	.049	.022	.236	.242	.097			
Research #/tow	2.27	6.06	4.26	9.11	19.35	5.55	2.82	3.48	3.10	1.64	3.44	3.80	3.43	3.80	3.44	4.55	12.10	1.89

Table 10c. Yellowtail flounder commercial and research[1] CPUE in NAFO Division 4VWX for 1970-87.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Canadian OTB1/TC4 (t/h)	.133	.340	.276	.125	.103	.203	.125	.087	.139	.181	.160	.176	.344	.332	.244			
Research #/tow	4.68	17.94	4.84	4.42	6.40	6.53	21.67	50.84	4.08	5.68	13.27	18.85	25.67	11.39	3.38	3.96	5.67	15.7

[1]Summer cruises, values calculated using the "STRAP" program, wingspread factor = 34.

Table 11. Stratified mean catch per tow at age (number), 4V American plaice, summer RV surveys, 1970-1987.

AGES	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
								Males										
1	0	0	0	0	0	0	0	0.05	0	0.29	0.02	0	0	0.01	0	0.27	0	0.07
2	0.06	0.48	0.81	0.23	1.72	0.74	0.3	0.12	0.16	1.26	0.35	0.42	1	0.53	0.88	0.83	0.62	0.36
3	2.49	1.02	1.88	1.44	2.81	5.31	3.71	1.14	0.09	1.85	5.88	1.57	2.04	2.29	0.78	3.07	0.81	0.85
4	4.49	6.49	0.98	1.26	3.28	2.82	18.6	2.56	0.83	2.97	2.22	11.6	4.39	3.85	5.31	2.84	4.02	3.14
5	11.8	8.45	5.36	1.19	5.7	2.97	6.16	6.1	1.33	8.79	3.62	2.78	8.56	4.55	7.84	5.03	3.25	3.73
6	8.31	11.5	5.15	3.08	1.65	1.74	6.52	2.02	2.99	6.45	8.37	1.86	5.12	8.23	5.12	3.56	5.47	5.29
7	7	6.77	10.1	3.83	6.4	1.68	4.43	3.02	1.77	11.4	11	7.49	4.73	3.56	12	3.37	4.65	3.68
8	5.07	5.04	4	5.52	10.1	4.09	5.26	3.03	1.57	4.87	15.5	5.56	3.78	2.93	4.84	3.59	1.93	1.34
9	2.6	3.62	2.33	2.2	8.44	2.83	8.1	4.03	1.29	4.25	8.08	6.66	3.32	3.65	2.46	3.71	1.1	1.56
10	0.89	1.62	2.2	0.95	4.2	3.48	6.29	2.23	1.49	3.5	4.68	2.29	2.76	3.16	5.39	2.49	0.57	0.87
11	0.81	0.92	0.69	0.82	1.77	2.39	2.4	0.76	0.87	1.79	2.82	0.87	0.26	2.31	1.88	1.87	0.2	0.15
12	0.38	0.73	0.58	0.32	2.27	0.68	1.55	0.49	0.93	1.53	2.33	0.58	0.06	0.71	1.77	1.49	0.22	0.19
13	0.07	0.29	0.12	0.1	0.28	1.11	0.47	0.16	0.03	0.55	0.85	0.45	0.24	0.31	1.94	0.55	0.26	0.23
14	0.17	0.52	0.1	0.09	0.16	0.18	0.08	0.21	0.05	0.05	0.06	0.65	0.39	0.53	0.58	1.09	0.02	0.02
15	0.15	0.4	0.22		0.05	0.36	0.03	0.08	0.05	0.08	0.03	0.65	0	0.21	0.22	0.19	0.04	0
16	0	0.27	0.11		0.02	0.09		0.02				0.28	0.13	0.21	0.06	0.14	0	
17	0	0	0		0	0.12						0.21	0.06	0	0.02		0.04	
18	0	0			0.07								0.06	0				
19	0	0.07			0.04									0				
20	0.02													0.09				
21																		
22																		
23																		
24																		
25																		
NK	0.17	0	0.05	0.32	0.55	0.33	0.03	0.08	0	0	0	0.06	0.16	0.02	0	0.14	0	
Tota	44.3	48.2	34.7	21.4	49.5	30.9	63.9	26.1	13.5	49.7	65.8	44	37.1	37.2	51.1	34.2	23.2	21.5
								Females										
AGES	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0.18	0	0.2	0.07	0
2	0	0.27	0.24	0.18	1.42	0.23	1	0.01	0.05	0.42	0.69	0.29	1.99	0.74	0.63	0.62	0.44	0.5
3	1.63	0.24	0.98	1.16	2.09	5.06	2.95	0.23	0.09	0.5	4.84	1.43	3.98	3	2.78	1.43	1.11	0.92
4	4.44	1.89	1.84	1.6	3.13	2.57	13.8	1.74	0.76	0.98	2.62	8.09	4.05	4.96	4.16	2.2	4.78	1.78
5	7.11	3.26	3.69	0.67	4.16	2.85	5.58	8.48	1.07	5.96	2.54	2.47	10.7	5.34	4.59	5.03	2.4	5.05
6	6.62	6.57	4.47	3.21	2.94	1.76	5.66	2.26	2.83	5.42	3.88	2.28	2.91	10.6	4.34	2.99	5.96	5.01
7	5.99	2.8	7.6	3.2	5.03	1.2	4.26	5.11	1.04	10	4.3	6.94	3.38	3.26	6.13	3.7	2.86	2.93
8	3.84	3.86	4.94	4.44	6.67	2.58	2.5	4.56	1.25	2.93	6.95	3.6	4.99	2.14	2.57	3.97	1.44	2.6
9	2.28	3.05	2.8	1.56	8.32	2.66	6.54	2.25	1.12	3.18	5.27	7.45	3.52	3.78	1.3	1.94	1.53	1.39
10	1.07	2.14	2.69	1.44	3.78	4.28	4.08	2.57	0.76	2.06	4.59	2.07	4.21	2.24	2.48	2.07	0.79	1.63
11	0.76	1.02	1.78	0.37	2.92	1.88	4.06	2.48	1.23	1.51	3.29	1.92	1.16	2.76	2.14	1.48	0.99	0.6
12	0.57	1.91	0.76	0.49	1.4	1.71	2.54	1.65	0.92	1.57	1.77	1.29	1.28	1.13	2.77	2.61	0.71	0.62
13	0.32	0.62	0.66	0.13	1	0.83	1.29	0.51	0.93	1.39	2.24	0.43	0.8	0.81	1.01	1.56	0.56	0.61
14	0.7	0.76	0.52	0.12	1	0.53	0.46	0.12	0.37	1.53	3.57	1.85	0.73	0.67	0.62	1.95	0.39	0.61
15	0.2	0.61	0.33	0.02	0.3	0.38	0.71	0.27	0.32	0.74	1.52	2.57	1.28	0.72	1.07	1.55	0.22	0.43
16	0.03	0.44	0.59	0.09	0.25	0.31	0.02	0.1	0.13	0.37	0.3	2.03	0.89	0.51	0.32	0.71	0.22	0.09
17	0.18	0.5	0.18	0.03	0.26	0	0.22	0	0.07	0.23	0.57	0.68	0.34	0.6	0.65	0.34	0.06	0.06
18	0.24	0.37	0.18	0.02	0.2	0.22	0.1	0.03	0.04	0.08	0.07	0.05	0.32	0.42	0.46	0.56	0.12	0.13
19	0	0.16	0.02	0	0.07	0.09	0.05	0.15	0.04	0.2	0.32	0.79	0.34	0.21	0.18	0.31	0.09	0.02
20	0.11	0.05	0.38	0	0.04	0.1	0.1	0		0.1	0.05	0.07	0.51	0.1	0.28	0.28	0.05	0.13
21	0.11	0.13	0.04	0	0.05	0	0.05	0.04		0.08	0.19	0.15	0.06	0.06	0.12	0.03	0.02	0.06

Table 11 (cont'd.).

22		0.09	0	0	0.03	0					0.06	0.07	0.14	0	0.11	0.1	0.02	0
23		0.05	0.03	0	0	0.11						0.04	0	0.02	0.03	0.06	0.03	
24		0.13	0	0.03	0.03								0	0	0		0	
25			0		0.07								0.07	0.08	0			
26			0.02												0			
27			0.02												0			
28															0.02			
NK	0	0.05	0	0.49	0	0.22	0.07	0	0.03	0.04	0.04	0.15	0.44	0	0.02	0		
Total	36.2	31	34.8	19.3	45.2	29.6	56.1	32.6	13.1	39.3	49.7	46.7	48.1	44.3	38.8	35.7	24.9	25.2
Rec. year-class			1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981			

Table 12a. Stepwise regression of stratified mean weight (kg)/tow in strata 47, 48, 49 and 50 vs. total landings, 4V American plaice, 1970-1986.

Stepwise Regression Y_1:4V plaice landings 4 X variables

Summary Information

F to Enter	4
F to Remove	3.996
Number of Steps	1
Variables Entered	1
Variables Forced	0...0

No Residual Statistics Computed

Note: 2 cases deleted with missing values.

Stepwise Regression Y_1:4V plaice landings 4 X variables

(Last Step) STEP NO. 1 VARIABLE ENTERED: X_4: Str 50 - n

R:	R-squared:	Adj. R-squared:	Std. Error:
.629	.395	.358	1623.073

Analysis of Variance Table

Source	DF:	Sum Squares:	Mean Square:	F-test:
REGRESSION	1	27575676.462	27575676.462	10.468
RESIDUAL	16	42149856.482	2634366.03	
TOTAL	17	69725532.944		

STEP NO. 1 Stepwise Regression Y_1:4V plaice landings 4 X variables

Variables in Equation

Parameter:	Value:	Std. Err.:	Std. Value:	F to Remove:
INTERCEPT	4497.921			
Str 50 - n	.001	3.927E-4	.629	10.468

Variables Not in Equation

Parameter:	Par. Corr:	F to Enter:
Str 47 - n	-.039	.023
Str 48 - n	-.378	2.503
Str 49 - n	.308	1.574

Table 12b. Stepwise regression of stratified mean number/tow in strata 47, 48, 49 and 50 vs. total landings, 4V American plaice, 1970-1986

Stepwise Regression Y_1:4V plaice landings 4 X variables

Summary Information

F to Enter	4
F to Remove	3.996
Number of Steps	1
Variables Entered	1
Variables Forced	0...0

No Residual Statistics Computed

Note: 2 cases deleted with missing values.

Stepwise Regression Y_1:4V plaice landings 4 X variables

(Last Step) STEP NO. 1 VARIABLE ENTERED: X_4: str50-w

R:	R-squared:	Adj. R-squared:	Std. Error:
.576	.331	.29	1706.862

Analysis of Variance Table

Source	DF:	Sum Squares:	Mean Square:	F-test:
REGRESSION	1	23111508.894	23111508.894	7.933
RESIDUAL	16	46614024.05	2913376.503	
TOTAL	17	69725532.944		

STEP NO. 1 Stepwise Regression Y_1:4V plaice landings 4 X variables

Variables in Equation

Parameter:	Value:	Std. Err.:	Std. Value:	F to Remove:
INTERCEPT	4831.954			
str50-w	.004	.001	.576	7.933

Variables Not in Equation

Parameter:	Par. Corr:	F to Enter:
str47-w	.166	.423
str48-w	-.221	.772
str49-w	.295	1.432

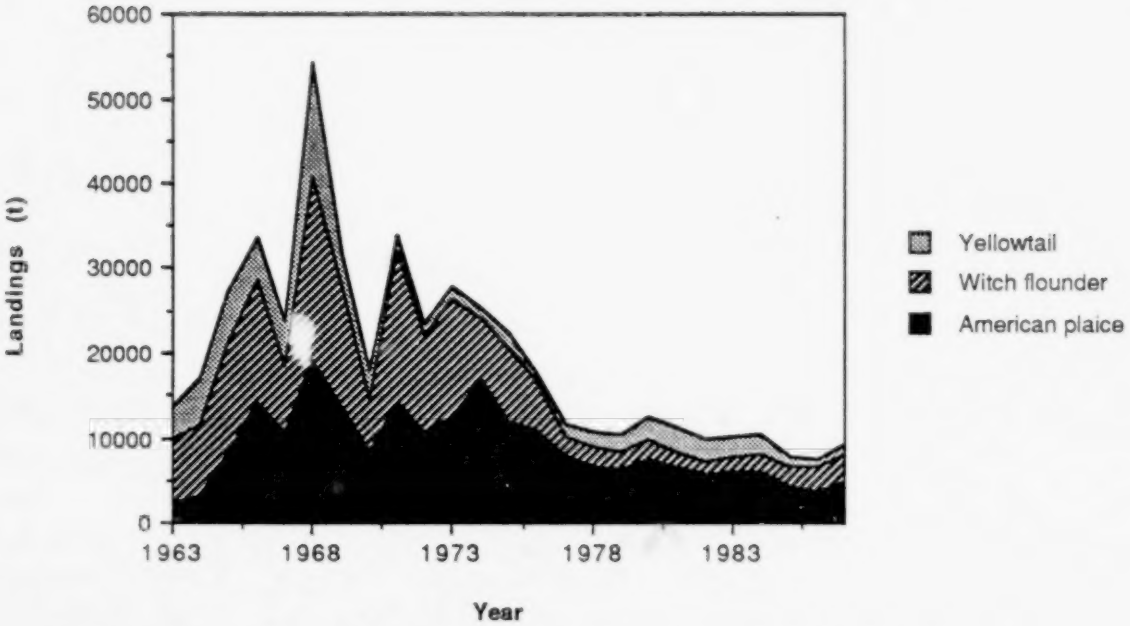
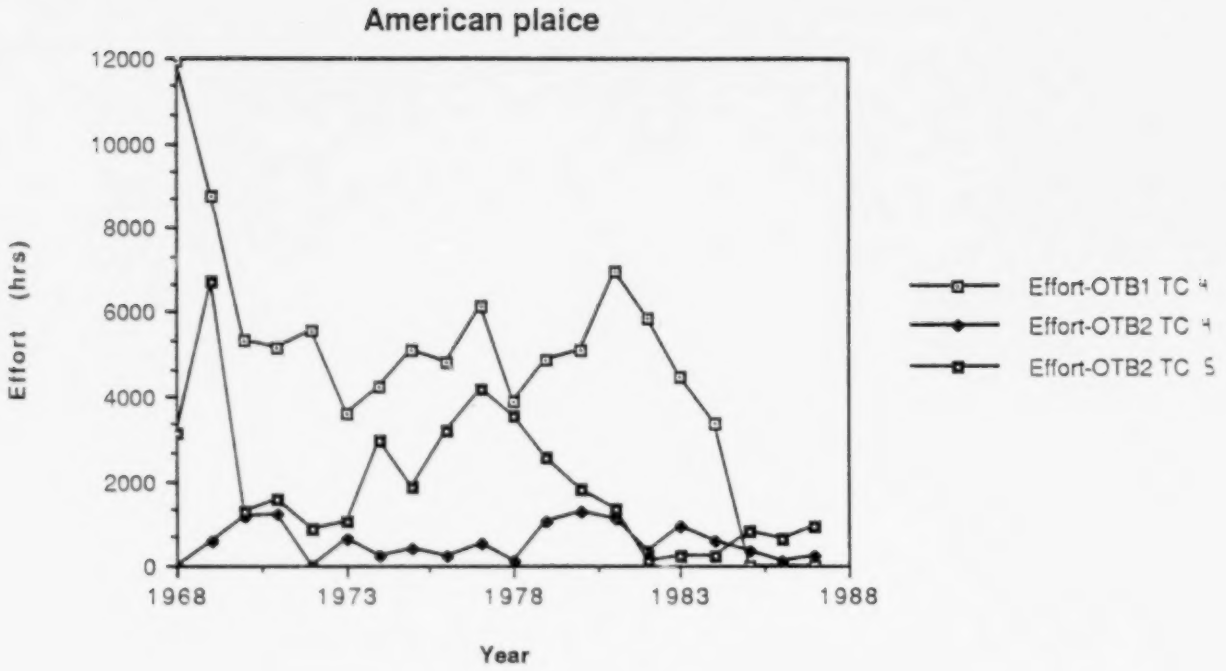


Fig. 1. Landings of flatfish stocks comprising 4VWX flatfish in NAFO Divs. 4VWX, 1963-1987.



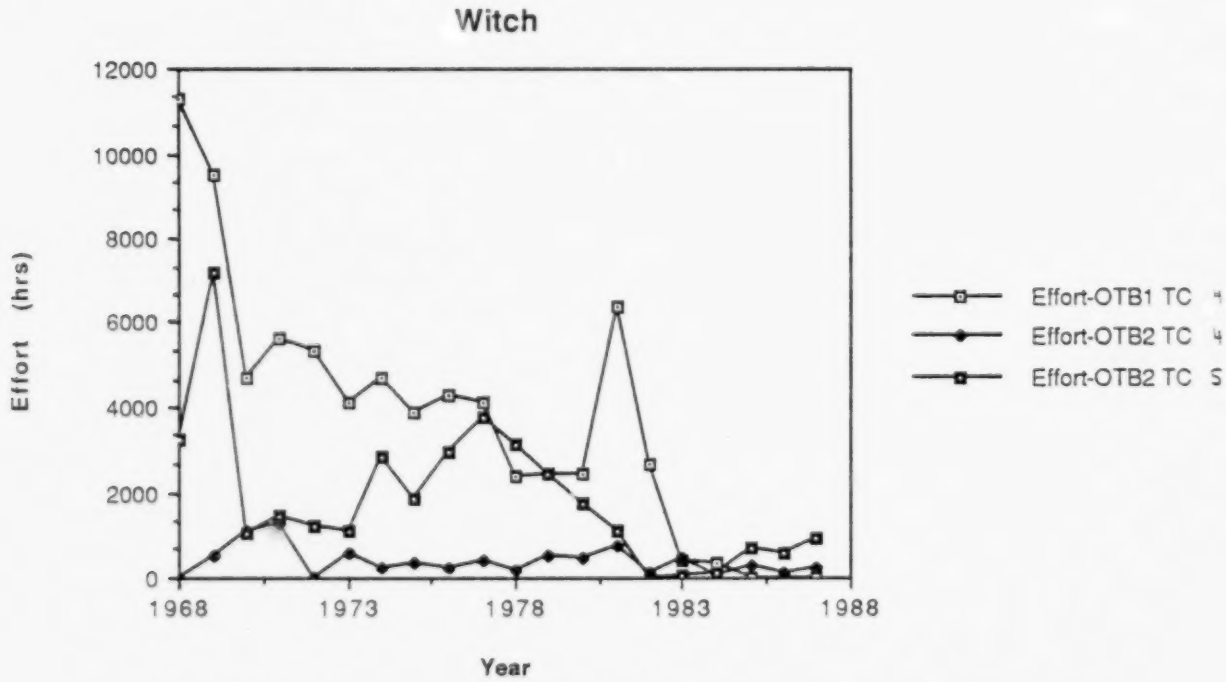


Fig. 2. Total directed effort for 4V American plaice and 4VW witch flounder, for various gear types, 1968-1987.

Fig. 3. CPUE (t/hour) for 4VW witch flounder, Scottish/Danish seiners, 1968-1987.

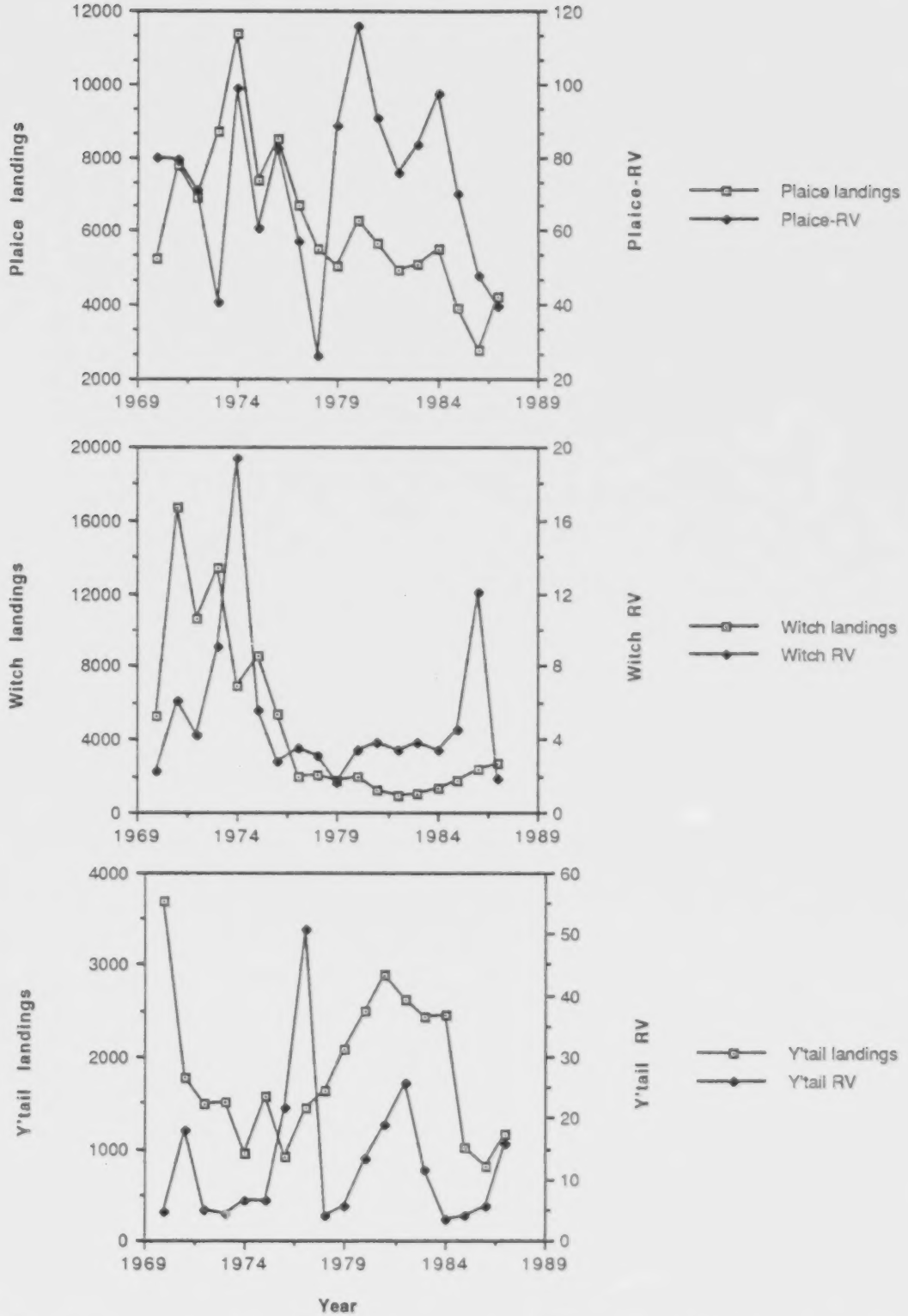


Fig. 4. Time series of landings and indices of abundance (number) from summer research vessel surveys, 4V plaice, 4VW witch and 4VWX uellowtail, 1970-1987.

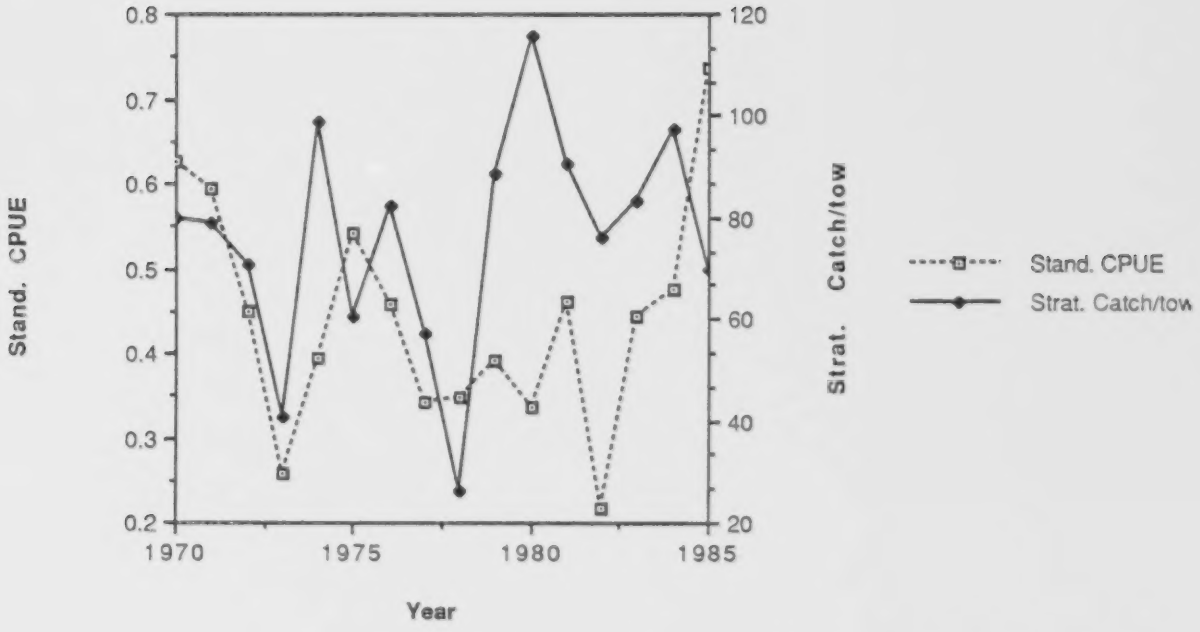


Fig. 5. Time series of standardized catch-per-unit-of-effort from summer research vessel surveys and stratified mean catch per tow, 4V American plaice, 1970-1985.

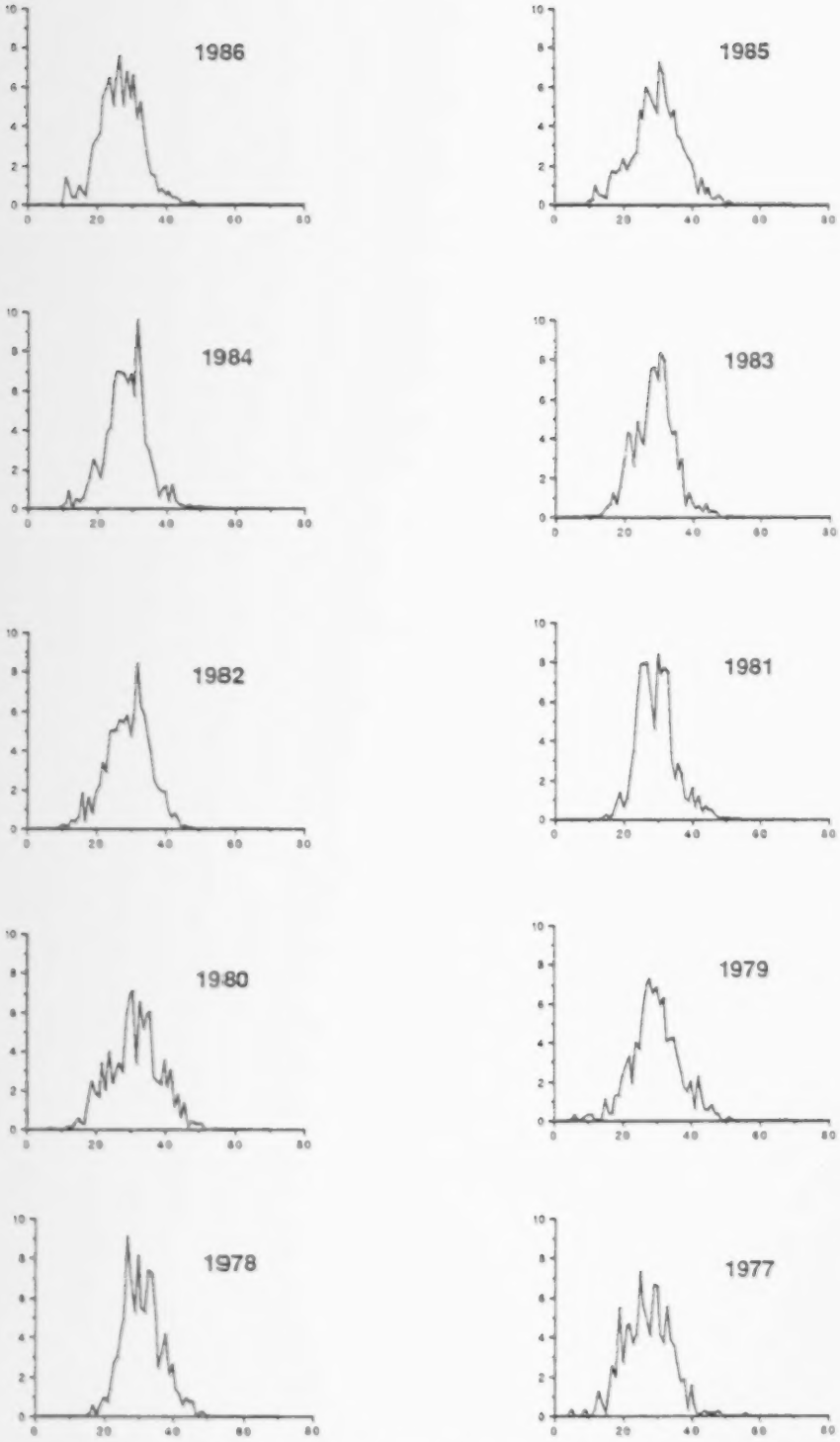
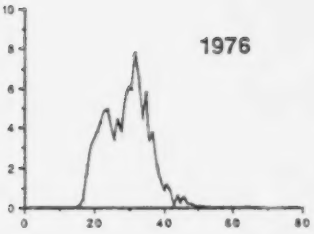
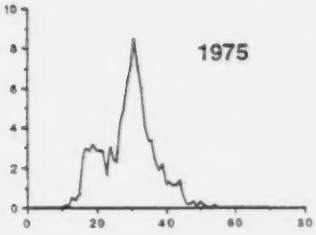
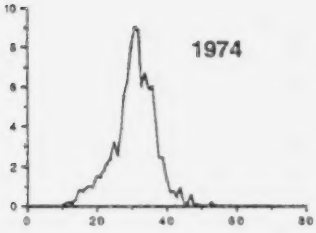
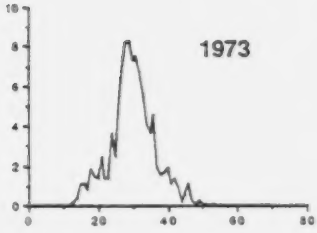


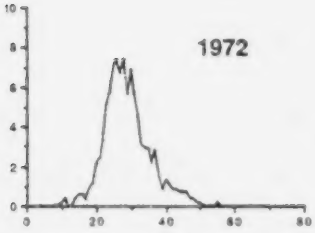
Fig. 6. Length-frequency distributions of male American plaice taken during summer research vessel surveys, 4V, 1970-1986. Y-axis is percent occurrence, and X-axis is length in cm.

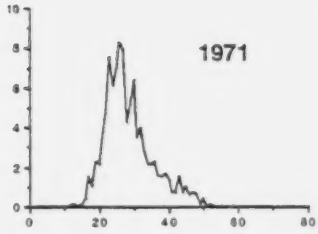












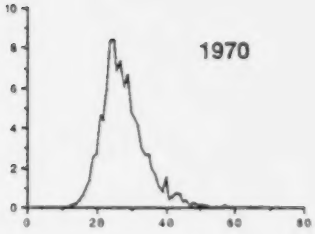


Fig. 6 (cont'd.).

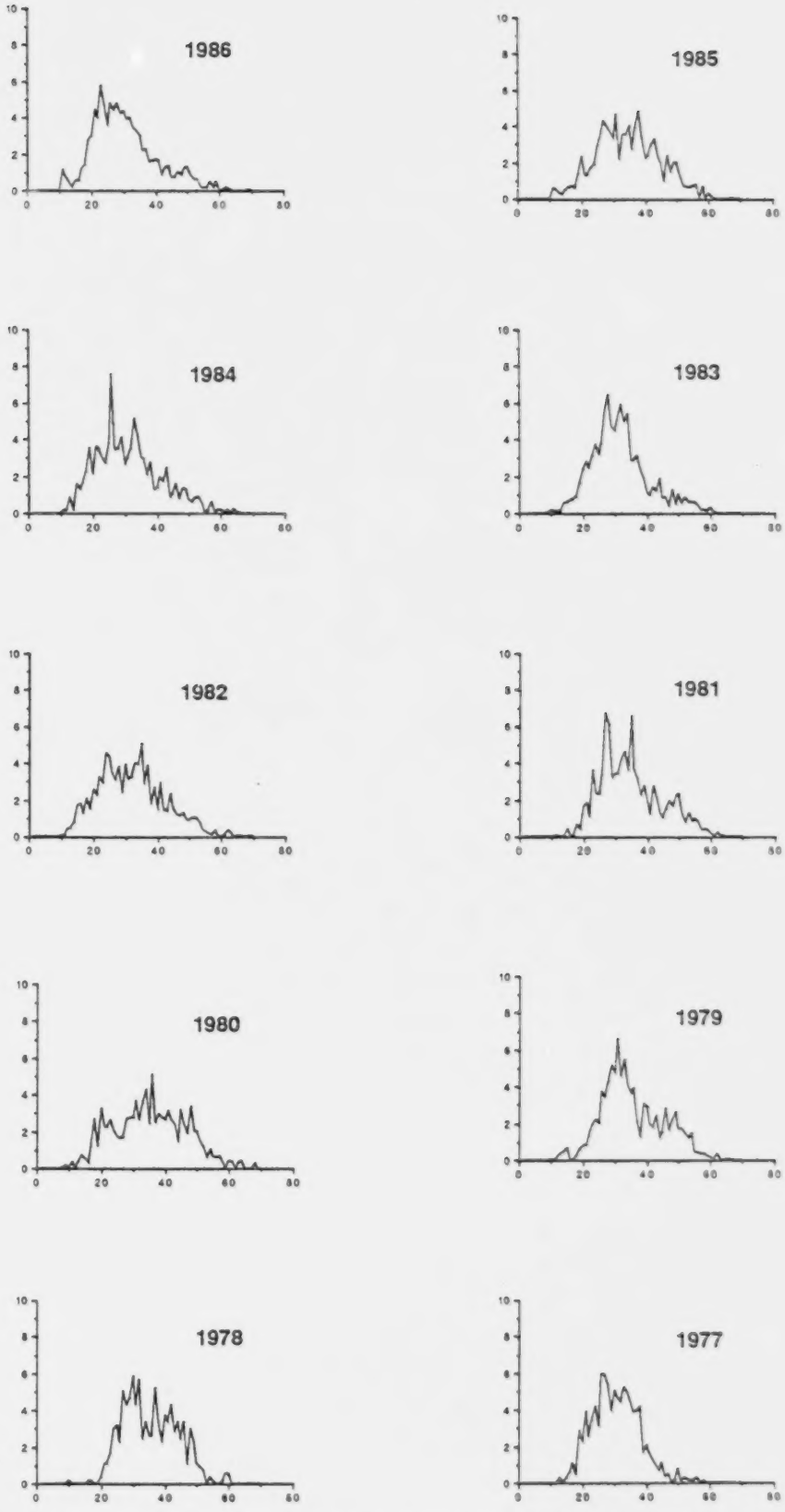
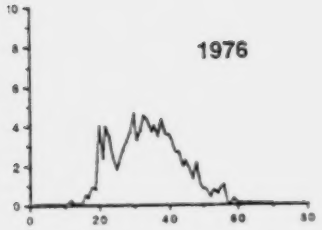
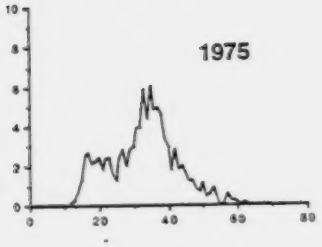
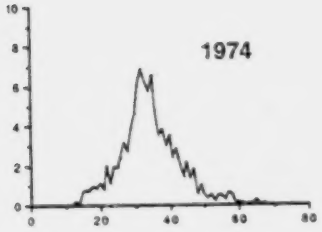
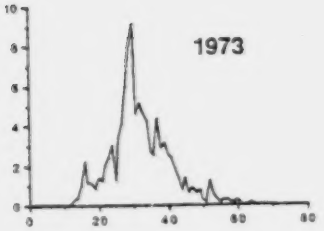


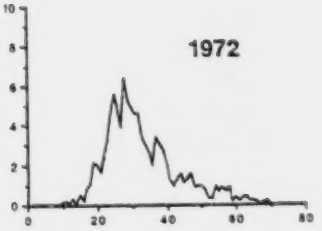
Fig. 7. Length-frequency distributions of female American plaice taken from summer research vessel surveys, 4V, 1970-1986. Y-axis is percent occurrence, and X-axis is length in cm.

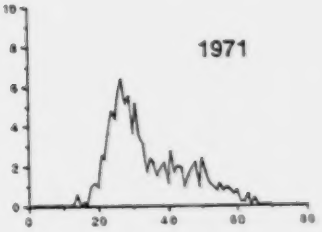












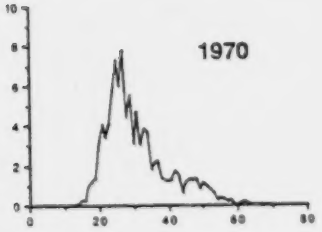
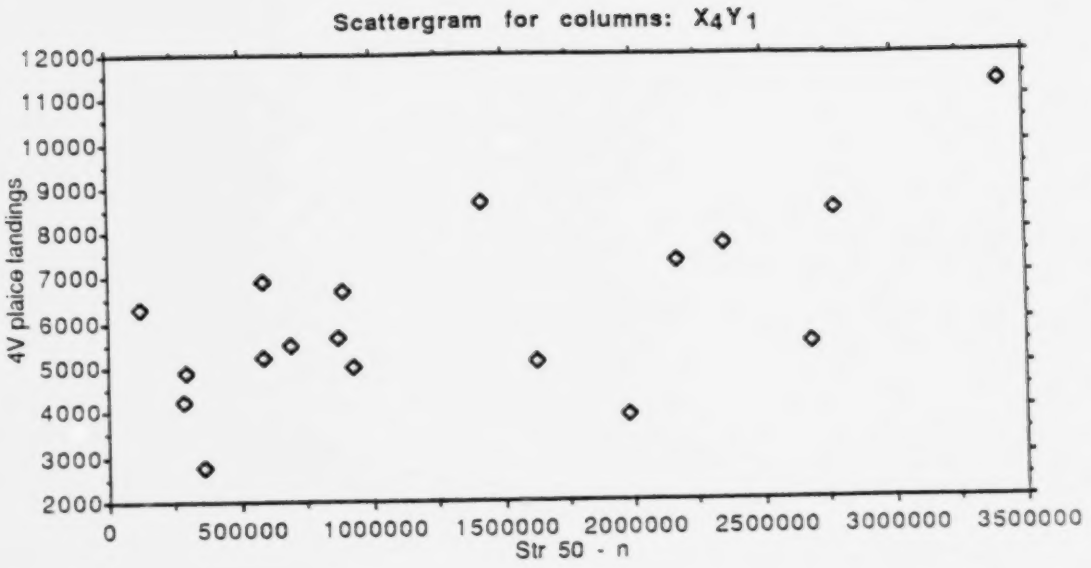


Fig. 7. (cont'd.).



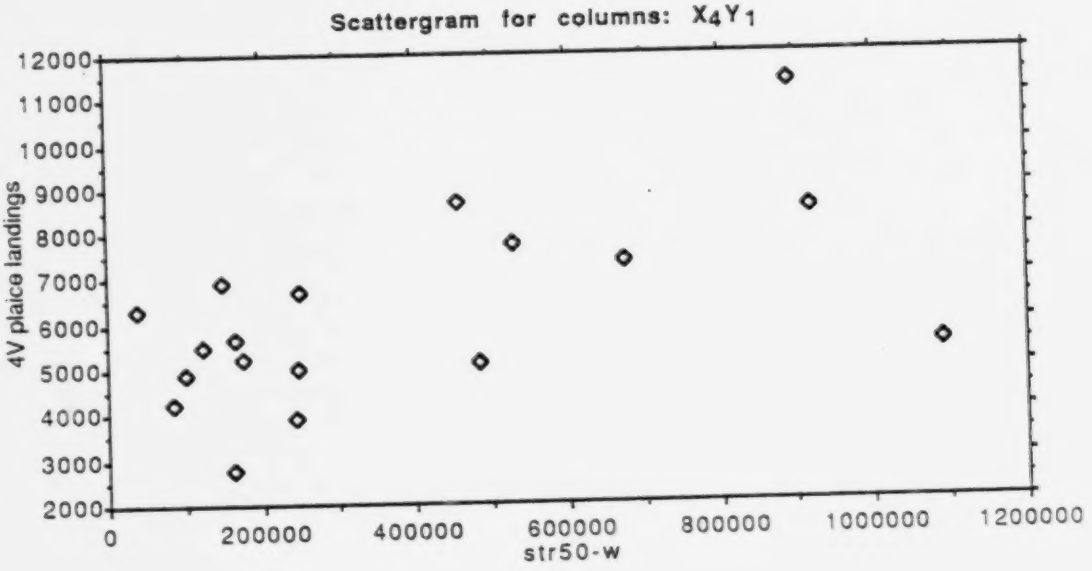


Fig. 8. Relationship of American plaice landings (t) to stratified mean catch/tow for summer research vessel surveys (numbers shown in top plot, weight in bottom plot), 4V, 1970-1987.

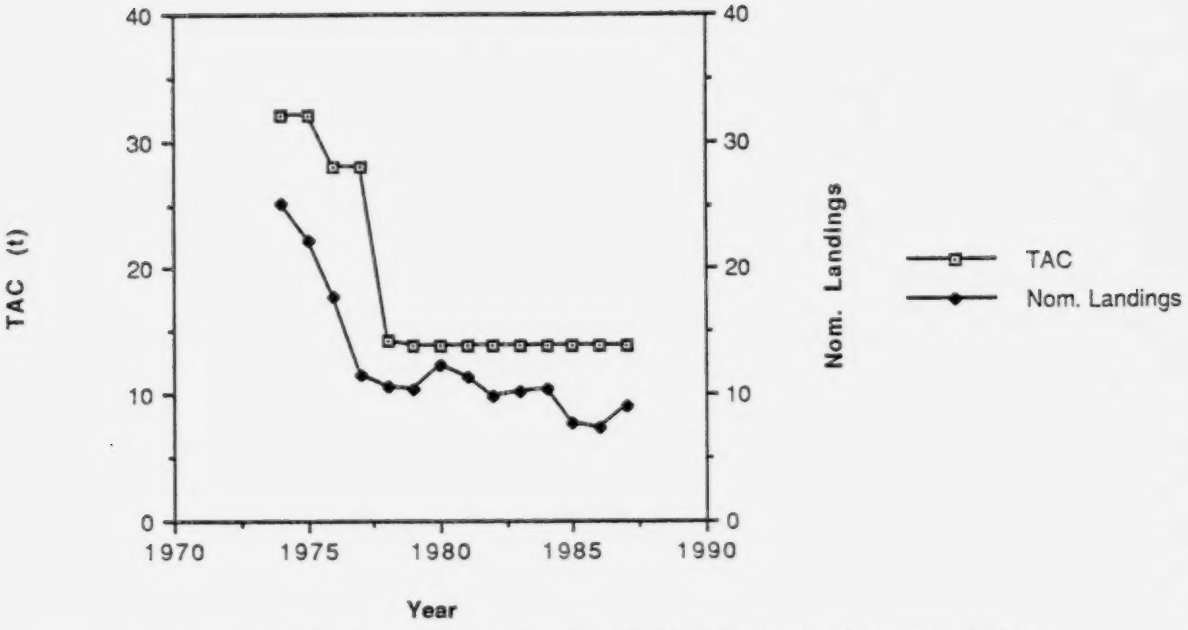


Fig. 9. Total landings of Scotian Shelf flatfish stocks comprising the TAC, and the TAC.

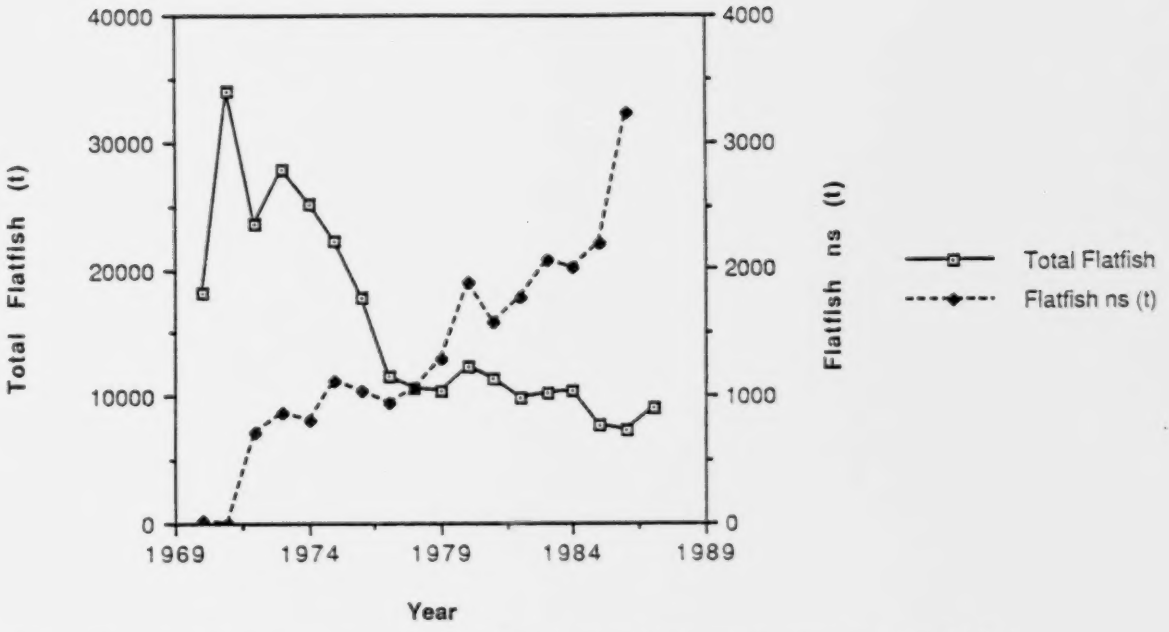


Fig. 10. Landings of "not specified" flatfish with respect to total landings of flatfish stocks comprising the TAC, Scotian Shelf, 1970-1986.